

CLAIMS

1. A method for determining the total mass flow through an engine comprising measuring the fuel mass flow to the engine, measuring the concentration of carbon dioxide, measuring the ratio of water to oxygen, measuring the ratio of carbon dioxide to oxygen or measuring the ratio of water to carbon dioxide in the gases exhausted from the engine, determining the air to fuel ratio in the engine from the fuel mass flow and the concentration of carbon dioxide, the ratio of water to oxygen, the ratio of carbon dioxide to oxygen or the ratio of water to carbon dioxide, determining the air mass flow through the engine from the air to fuel ratio and calculating the total air and fuel mass flow through the engine by adding the air mass flow through the engine to the fuel mass flow to the engine.
2. A method as claimed in claim 1 wherein measuring the concentration of carbon dioxide comprises detecting infra-red radiation emitted by carbon dioxide in the gases exhausted from the engine and determining the concentration of carbon dioxide.
3. A method as claimed in claim 1 wherein measuring the concentration of carbon dioxide comprises detecting infra-red radiation absorbed by carbon dioxide in the gases exhausted from the engine and determining the concentration of carbon dioxide.
4. A method as claimed in claim 1 wherein measuring the ratio of water to oxygen comprises detecting infra-red radiation absorbed by water in the gases exhausted from the engine, detecting near infra-red radiation absorbed by oxygen in the gases exhausted from the engine, determining the concentration of water, determining the concentration of oxygen and calculating the ratio of water to oxygen.
5. A method as claimed in claim 1 wherein measuring the ratio of carbon dioxide to oxygen comprises detecting infra-red radiation absorbed by carbon dioxide in the gases exhausted from the engine, detecting near infra-red radiation absorbed by oxygen in the gases exhausted from the engine, determining the concentration of carbon dioxide, determining the concentration of oxygen and calculating the ratio of carbon dioxide to oxygen.
6. A method as claimed in claim 1 wherein measuring the ratio of water to carbon dioxide comprises detecting infra-red radiation absorbed by water in the gases exhausted from the engine, detecting infra-red radiation absorbed by carbon dioxide in

the gases exhausted from the engine, determining the concentration of water, determining the concentration of carbon dioxide and calculating the ratio of water to carbon dioxide.

7. A method as claimed in claim 1 comprises irradiating the gases exhausted from the engine with a light.

8. A method as claimed in claim 7 comprising irradiating the gases exhausted from the engine with a laser light.

9. A method as claimed in claim 1 comprising detecting infrared radiation absorbed or emitted by the gases exhausted from the engine at a plurality of lines across the exhaust of the engine.

10. A method as claimed in claim 9 comprising moving a detector.

11. A method as claimed in claim 9 comprising moving a light source.

12. A method as claimed in claim 9 comprising moving at least one mirror.

13. A method as claimed in claim 1 wherein the engine is a gas turbine engine.

14. A method as claimed in claim 13 wherein the engine is a turbofan gas turbine engine.

15. An apparatus for determining the total mass flow through an engine comprising means for measuring the fuel mass flow to the engine, means for measuring the concentration of carbon dioxide, means for measuring the ratio of water to oxygen, means for measuring the ratio of carbon dioxide to oxygen or means for measuring the ratio of water to carbon dioxide in the gases exhausted from the engine, means for determining the air to fuel ratio in the engine from the fuel mass flow and the concentration of carbon dioxide, the ratio of water to oxygen, the ratio of carbon dioxide to oxygen or the ratio of water to carbon dioxide, means for determining the air mass flow through the engine from the air to fuel ratio and means for calculating the total air and fuel mass flow through the engine by adding the air mass flow through the engine to the fuel mass flow to the engine.

16. An apparatus as claimed in claim 15 wherein the engine is a gas turbine engine.

17. An apparatus as claimed in claim 16 wherein the gas turbine engine is a turbofan gas turbine engine.

18. An apparatus as claimed in claim 15 wherein the means for measuring the concentration of carbon dioxide comprises at least one detector.

19. An apparatus as claimed in claim 18 wherein the detector comprises a spectrometer and a photo-detector, the spectrometer is optically coupled to the photo-detector.
20. An apparatus as claimed in claim 19 wherein the spectrometer is a Fourier transform spectrometer.
21. An apparatus as claimed in claim 19 wherein the means for measuring the concentration of carbon dioxide comprises a light source.
22. An apparatus as claimed in claim 21 wherein the light source is a laser.
23. An apparatus as claimed in claim 22 wherein the laser is a tunable laser.
24. An apparatus as claimed in claim 22 wherein the laser is a diode laser.
25. An apparatus as claimed in claim 15 wherein there are means to scan the gases exhausted from the engine.
26. An apparatus as claimed in claim 25 wherein the means to scan comprises one or more mirrors.
27. An apparatus as claimed in claim 22 wherein there are a plurality of lasers.
28. An apparatus as claimed in claim 27 wherein the lasers are tuned to different wavelengths, there are means to switch the lasers on sequentially.